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ABSTRACT

The report examines, from a cognitive developmental view, research on the teachable moment or critical learning period in handicapped infants. The author explains that developmental gaps are produced by a mismatch between the infant's readiness and opportunity to learn. Characteristics and educational implications of specific handicapping conditions (including blindness, Down's syndrome, autism, cerebral palsy, amputation, physical handicaps, severe handicaps, multiple handicaps, spina bifida, and deafness) are detailed for the following aspects of development: visual pursuit and permanence of objects, means-ends relationships, causality, construction of objects in space, behaviors relating to objects, imitation, motor development, Stage I of the sensorimotor period and its relationship to cognition, and language development. Emphasized in each discussion is the importance of understanding the effects of the infant's handicap on overall development, designing alternative strategies for minimizing or preventing the effect of the handicap, and recognizing when the infant is ready to acquire information from an interaction. (CL)

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THE TEACHABLE MOMENT AND THE HANDICAPPED INFANT

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INTRODUCTION

Teaching as much as possible as quickly as possible and as early as possible has been among the primary goals of caregivers of handicapped infants. The emphasis on serving children in infancy is confirmed in that 21% of the Bureau of Education for the Handicapped (BEH) demonstration and outreach programs focus on children under 3 years of age (Hayden, 1979). In our naive cognizance of the plasticity of the infant's central nervous system and the beneficial effects of early intervention with infants manifesting a variety of handicaps (Bobath, 1967; Bricker & Bricker, 1973; Downs, 1968; Fraiberg, 1977; Hanson & Schwarz, 1978; Hayden & Haring, 1976; Horton, 1976; Kaiser & Hayden, 1977), we special educators have focused our energies on narrowing the gap between the perceived handicap and the perceived notion of what is normal behavior. Primary caregivers tend to get caught up in this enthusiasm and, as a result, place more emphasis on task accomplishment than on the acquisition and generalization of the concept behind the task. The training activity, then, becomes an end in itself, rather than one step toward synthesizing discrete experiences into a knowledge base (Dunst, 1978b; Robinson & Robinson, 1978). This point is clearly illustrated by examining the effects of parent intervention on the behavior of two handicapped infants.

Case Studies

One parent, an energetic, dedicated mother of a 10 month old Down's syndrome child enrolled from the age of 2 weeks in an infant stimulation program, spent a deal of time training her child to perform specific tasks which she believed were important in enhancing her child's development. She worked diligently to instruct her infant how to remove a cloth that covered a toy and how to pull a toy by a string. During an educational assessment, the child successfully completed these specific tasks but couldn't demonstrate her understanding of how objects are related. Thus, the infant performed the simple motor responses that she had practiced, but did not associate such objects as cup and spoon or hat and head. When given this feedback, the mother showed anger and disappointment. She complained that the books didn't <u>tell</u> her to put a hat on her head or to stir a spoon in a cup.

Contrast this mother's coaching with that of a father of a 10 month old myelomeningocele child. Although the man was frustrated by his own limited eighth grade education, he generated some amazingly natural learning adventures through play. As his son watched, this ingenious father fostered the learning of object permanence and causality concepts by alternately dropping his car keys into each shirt pocket and then slowly pulling them out. Before long the youngster learned that although out of sight, the keys were still there. The child delighted in retrieving the keys and handing them to his father so the game could continue.

In another favorite game, the father covered his face with a diaper during the changing process. The baby loved tugging the diaper away and then

returning it to his father. In these and other spontaneous games, the child was practicing a variety of experiences that facilitated his attainment of the concept of object permanence.

"Play Is the Work of the Child"

Too often, we as educators forget Piaget's tenet that play is the work of the child and that normal children learn incidentally from their experiences in natural settings. Kaiser and Hayden (1977) pointed out that regardless of the variations in early environments, "most babies learn the tasks of infancy with no more formal 'teaching' than goes on in most households in which a baby lives" (p. 9). When the opportunities provided for learning are inappropriately matched with the infant's level of readiness, the learner displays a behavioral repertoire of scattered-skill development. The irony is that infants with handicaps are often dependent on adults to bring them experiences and interactions they cannot self-initiate (Kaiser & Hayden, 1977).

Teachable Moment Concept

Educators of handicapped infants have repeatedly recognized the importance of the concept of the teachable moment or of critical learning periods (Bobath, 1967; Downs, 1968; Freedman, 1964; Hayden, 1979; Norris, Spaulding, & Brodie, 1957). The premise behind the teachable moment is that there are certain stages during the child's development when his or her body and mind are most ready to acquire a given skill.

Norris, Spaulding, and Brodie (1957) discussed the importance of both the timing of the learning and the opportunity available to develop a particular set of behaviors. When opportunities are available at the time of optimum readiness, skills are rapidly acquired through trial and error and subsequent practice. Assimilation and accommodation of any behavior is dependent on a variety of experiences interpreted by intact sensory, motor, and organizational systems. When the normal process of development of any one of these systems is interrupted, so is the delicate balance between readiness to learn and opportunity to learn. The impact of such disequilibrium can have devastating effects on the learner.

It is feared that the more time that elapses between the period of maximum physical and mental readiness and the opportunity to learn, the greater the risk that the child may not acquire a given behavior. Not only may information obtained through an impaired system be distorted, but if the system is totally dysfunctional, the child may never acquire equivalent information. Even if the infant learns through compensatory mechanisms and alternative modalities, the information accrued from the adapted system can never approximate the quantity or quality of data that would have been perceived by an intact modality or processed by an efficient central nervous

system. During the sensorimotor period of development, the teachable moment and the opportunity to develop functional adaptive, linguistic, and motoric independence are generally out of synchronization for handicapped children.

Cognitive-Developmental Framework

A Piagetian, cognitive-developmental framework (Dunst, 1978b; Uzgiris & Hunt, 1975) provides a means for comparing developmental patterns of normal and handicapped infants. Research confirms that although the time and rate of skill acquisition differs among handicapped children, the sequence of development remains constant. (For research on the deaf, see Best and Roberts, 1976; visually impaired, see Fieber, 1977; cerebral palsied, see Tessier, 1969; and mentally retarded, see Kahn, 1976; Kahn, 1979; Silverstein, McLain, Brownless, and Hubbell, 1976; and Weisz and Zigler, 1979.) Piaget's (1952) concept of decalage, the acquisition of some concepts on a level more advanced than others (Wadsworth, 1978), provides a functional framework from which to examine the effects of missing the teachable moment. Dunst (1978b) provided a comprehensive explanation of vertical and horizontal decalage and how they relate to curriculum development for handicapped infants. According to Dunst, the concept of decalage distinguishes between "levels of achievement (vertical decalage) and areas of performance (horizontal decalage)" (p. 31). Vertical decalage (achievement) is represented by the six steps described by Piaget (1952) while horizontal decalage (performance) is represented by the seven cognitive domains or branches elaborated by Uzgiris and Hunt (1975) (see Table 1).

TABLE 1

Comparison of Vertical and Horizontal Decalage

Vertical	Horizontal
Stage I: Use of reflexes	1. Visual pursuit and permanence of objects
Stage II: Primary circular reactions	2. Means-ends relationships
Stage III: Secondary circular reactions	3. Causality
	4. Behaviors relating to objects
Stage IV: Coordination of secondary circular reactions	5. Construction objects in space
	6. Vocal imitation
Stage V: Tertiary circular reactions	7. Gestural imitation
Stage VI: Invention of new means through mental combinations	

In order for development to proceed smoothly and in a consolidated manner, the infant simultaneously should be learning skills across all branches of cognitive schemes and within sequential levels of development. "Each of the sensorimotor constructs (object permanence, causality, etc.) emerges through the identical six stage integration process represented by vertical decalage, yet not necessarily at the same rate of development" (Dunst, 1978b, p. 45). When this sequential integration is ignored and artificial teaching situations are arranged in which emphasis is on the design of isolated tasks, concept generalization and "learning how to learn" are impeded.

Special educators charged with the responsibility of arranging or managing effective and functional learning environments should be aware of how infants learn, what can go wrong with the developmental process when an infant is handicapped, and when and how to intervene with specific children in order to optimize the match between readiness and opportunity to learn. In summary, what skills is the child ready to acquire? How many different "incidental" ways can the skills be presented? How can one teach the infant to compensate for sensory or mental deficits? Has the child generalized the skill to different stimuli and environments? Only when each of these variables has been addressed can one ensure that the teachable moment has arrived.

VISUAL PURSUIT AND PERMANENCE OF OBJECTS

Visual pursuit and the permanence of objects is initiated when the child fixates his or her gaze on lights, faces, and other objects. In time, the discovery is made that the world is a permanent place and that things continue to exist even when the child does not see them. As looking progresses to tracking the movement of objects through various positions in space, the child learns to anticipate the point of reappearance of an object. Children also learn that objects do not always look the same. Shape and color may change as the object is viewed from different angles. An object that has been tracked to its point of rest can normally be retrieved when it is hidden or partially hidden under one or more barriers. A child who has internalized this concept is able to search systematically for toys and other objects not seen for a period of time.

Blind Infants

For the blind infant, the progression of object permanence is arrested in the initial phase of gazing and looking. The child with severe visual limitations may be unable to orient to light sources, much less track an object in a 180^{0} arc. The partically sighted child may not perceive all the details or dimensions of an object. If a child has a distorted perception of an object in its entirety, then recognition of it when it is only partially visible will be a problem. A visually impaired child who is unable to track an object as it moves through space will not know that the object has disappeared, much less

where it has gone. Therefore, the ability to project where an object will reappear is not developed. The blind infant has no way of knowing that a toy still exists once it is removed from his or her grasp, and therefore there is no reason to search for it. Lack of vision as an integrator of sound and touch complicates and prolongs the development of the infant's understanding that he or she can maintain contact with the world.

Table 2 summarizes the developmental progression of an infant who does not have vision to help integrate auditory and tactile inputs (Fraiberg, 1977).

Contrary to popular misconceptions that audition automatically compensates for a blind child's lack of sight, Fraiberg (1977) showed that sound is not used to locate objects until the last quarter of the first year. Not only may the concept of object permanence be delayed as much as a year in the blind child (Warren, 1977), but independent movement into space will also lag behind expected norms. Adelson and Fraiberg (1974) discovered that until blind infants learn to reach for objects on the basis of sound cues alone, they do not creep or walk independently, which means a 4 to 7 month delay in locomotion skills. Even at this stage, the blind child has passed a teachable moment, and the effects are seen in delayed integration of movement and auditory schemes for reaching, maintaining contact with pleasurable input, and for independent mobility.

Down's Syndrome Infants

Fantz, Fagan, and Miranda (1975) found that the visual development of Down's syndrome infants parallels that of normal infants with regard to gaze fixation; maturation of elementary optical, oculomotor, and neural mechanisms for pattern recognition; and visual motor response. Characteristic of the Down's infants, however, is delayed development of preference for certain types of visual patterns. Down's infants develop a preference for curved patterns (e.g., bull's eye) 2 to 4 weeks later than normal infants. Preference for novel stimuli over familiar stimuli appears in normal infants at 13 weeks, but Down's infants do not show this preference until 24 weeks. Photographs are preferred over a schematic face presentation by normal infants at 5 months, whereas the Down's infants' preference for photographs lags 2 to 4 months. In a similar vein, the Fantz, et al. study (1975) pointed out that normal infants of 5 months demonstrate recognition memory for face photographs while Down's infants of 17 to 29 weeks still do not display this behavior. Fagan (1978) implied that this recognition deficit represents more than just difficulty with visual functioning and supports earlier hypothese (Fantz, et al., 1975) that perceptual cognitive development may be retarded in Down's infants. Because recognition of variables such as depth cues, brightness, and texture gradients is highly dependent on the integration of experiences, this early lag in visual perceptual development is though to offer a clue to the slowing of progress in the year old Down's infant as he or she approaches object permanence tasks of increasing complexity (Fantz, Fagan, & Miranda, 1975). Furthermore, Fagan (1978) proposed that Down's

TABLE 2

The Developmental Progression of Pursuit and Permanence of Objects in the Blind Infant: Touch Versus Sound

Chronological Age	Touch Cue	Sound Cue
6-7 months	When a toy is removed from the child's hands, the action of the hands briefly continues. A toy touched to the hand activates a grasping response.	The sound of a toy elicits alertness but no orientation of the head to the sound source. A sound elicits no motion of the infant's hands.
7-8 months	When a toy is removed from the child's grasp, rudimentary behavior occasionally occurs. The hand moves randomly across the place where contact was lost. The search is brief and unsystematic. A chance encounter with the toy elicits grasping behavior.	If a toy is removed from a child's grasp prior to the activation of its sound, searching movements will not occur when the sound is turned on, but the hand will open and close. Isolated instances of head turning toward the sound can now be observed. There is no use of sound to track or locate a toy.
8-11 months	Frequent intentional reaching occurs in the locale where the infant lost contact with the toy.	If the toy makes sounds, the infant can occasionally find its location through its sound cue. The fingers move to the sound cue alone. No searching is observed.
11-13 months	Search patterns now take into account the place where the lost object had been tactually experienced.	The infant reaches directly to the sound cue alone. The infant pursues an out of reach object on the basis of the sound cue alone.

Adapted from Fraiberg, S. Insights from the blind. New York: Basic Books, 1977.

infants' failure to recognize and develop preference for a face photograph implies retardation of social recognition as well as of perceptual cognitive processes. (See also Cicchetti & Stroufe, 1976.)

Autistic Infants

If the construct of permanence develops with gazing behavior, the autistic child's inability to modulate sensory input, particularly visual stimuli, may interfere with his or her cognitive readiness to develop early memory. Ornitz and Rivto (1976) observed that autistic children often appear unaware of new persons or objects in their environments, although Rutter and Schopler (1978) posited that gaze behavior is not absent, but the way in which it is used often reflects lack of interest and/or avoidance. Superficial or inconsistent visual pursuit may keep the child from anticipating the reappearance of objects and thereby may impede the development of systematic and organized search strategies. Rutter and Schopler pointed out that when the autistic infant fails to follow his mother through the house as she conducts her daily activities, the teachable moment may be missed for establishing organized memory traces.

Cerebral Palsied Infants

A number of severe deficits associated with cerebral palsy can interfere with the development of object permanence. The infant's gaze may be tied to his or her retention of a tonic neck reflex; therefore pursuit across the midline, either vertically or horizontally, may be restricted. Athetoid infants frequently lack the postural fixation necessary for steady gaze and controlled visual pursuit. Visual field defects such as hemianopsia may prevent the cerebral palsied infant from maintaining pursuit through a 180° arc and from fixating the point of disappearance and reappearance of a displaced object. Severe upper limb involvement may keep the infant from confirming the anticipated location of a displaced object since he or she cannot physically remove the barrier obstructing the object. Physical limitations interfere with the teachable moment for integrating visual and motor information. Such behaviors as tracking and retracing the path of travel of a desired object are critical to the development of efficient information storage and retrieval systems.

DEVELOPMENT OF MEANS-ENDS RELATIONSHIPS

As the infant engages in hand-watching behavior, the stage is set for the development of means-ends relationships. As the child begins reaching for things, the realization dawns that the hand can be used as a tool to obtain desired ends. Through exploration with the environment, children learn to appreciate the use of other objects as intermediate agents for procuring objects beyond their reach. It is in this domain that goal directed behaviors, foresight, and eye-hand integration abilities emerge.

Blind Infants

Because blind infants do not even see their hands, much less objects beyond them, there is naturally a failure to understand the potential use of hands as tools for obtaining objects (see Table 2). The gap in the integration of eye and hand continues to broaden as the blind child is faced with the problem of obtaining things beyond reach. If the child cannot see the relationship of a support or an intermediate object such as a string or a stick to the means of reaching a toy, how will this child understand its role in the acquisition of the desired goal?

The effects created by waving the hands before the eyes in the presence of a light source are so intriguing to many visually impaired-multiply handicapped, deaf-blind, autistic, and severely mentally retarded children that they never progress to extending their hands for exploration and manipulation. Instead, this group of children fixate on a self stimulatory level rather than realizing the hand's potential as a means to an end.

Blind and many partially sighted children lack the ability to compare and contrast visual information and to receive accurate visual feedback from trial and error manipulations. This loss of integrity of the visual-motor system may delay the process of thinking prior to acting and interfere with the development of foresight and sequential planning behaviors. According to Reynell (1978), blind children's cognitive processes begin to parallel those of their sighted peers around the age of 3 or 4 years, when intellectual understanding begins to take the place of visual perceptual learning. Significant in Reynell's statement is that normally developing blind children do close the gaps that accrue in the early stages of learning when they are "able to use intellectual means to transcend perceptual learning (and) find ways around visual difficulties" (p. 297). The visually handicapped infant with additional handicapping impairments may, however, never discover these ways.

Cerebral Palsied Infants

The cerebral palsied child's retention of primitive reflexes interferes with dissociated eye and upper extremity movements. It is not unusual for the child who retains the asymmetrical tonic reflex (Figure 1) to be unable to deviate his or her gaze from its fixed position in the direction of the face side of the reflex. These individuals may never achieve vertical gaze or be able to cross midline with their eyes. Physical handicaps also prevent these children from extending their reach for things or pull toys toward their midline.

Amputees

Unless children with upper unilateral or bilateral amputation are taught

FIGURE 1. Asymmetrical Tonic Neck Reflex.

compensatory patterns of reaching with prosthetic devices or with their feet, they will have no means of reaching, grasping, or pulling objects. How ironic that before children can be taught to use devices such as cable hooks, they must first be cognizant of the utility of the tool concept and understand that an intermediate object can be used as an extension of themselves for the purpose of acquiring what is wanted.

When the teachable moment occurs for integrating seeing with reaching and grasping for problem solving, the sensory and physically impaired child's body and the mentally retarded child's mind are not ready to assimilate these schemas for problem solving and for the development of efficient prehensile abilities.

CAUSALITY

Causality is the basis for the development of communication. It develops from a child's desire to retain pleasurable stimuli and progresses as the child's desire to retain pleasurable stimuli and progresses as the child anticipates events associated with specific actions and objects (Fieber, 1977). Initially, the child actively attempts to make interesting spectacles reoccur by engaging in familiar swiping, waving, kicking, and bouncing strategies. Once cognizant that he or she is responsible for the pleasurable results obtained from certain motor behaviors, the child anticipates future occurrence of these events, for example the appearance of mother and the nipple or bottle with his or her cry. As children progress in the development of causality, they begin to employ specific vocal or gestural procedures to direct adults to continue pleasurable events. Through these early communicative signals, the child begins to perceive how certain behaviors elicit desired reactions from others. The child learns that upon waving his or her arms up and down at the termination of an intriguing event created by the adult, or bouncing up and down at the termination of a game of "horsie," the adult is likely to interpret these actions as a request for more of the same. As the child continues to interact with the environment, he or she begins to acquire an array of vocalizations and gestures that are selectively applied in specific contexts in order to achieve a desired result. Aware of this ability to initiate actions and to cause others to perform desired behaviors, the child begins to seek out the causal agent for a variety of occurrences such as activating toys, opening doors, and so on.

Causality is perhaps the most vulnerable, the least understood, and the most difficult cognitive domain in which to help parents learn effective intervention strategies. Parents of blind children must learn to react to the subtleties of hand movements and body postures, while parents of seriously physically handicapped infants must be closely attuned to the infant's eyes and changes in postural tone.

The body posture and facial expressions of the deaf child, as well as communicative context, govern how parents interpret and respond to the deaf

infant's behavior. Timing and quality of response are critical elements for parents who are trying to foster communication in severely/profoundly mentally retarded infants. The majority of these handicapped children are likely to be seriously delayed in making the connection between their behavior and its effect on the environment.

Blind Infants

Visually impaired or blind children who do not observe their hands or feet and who have passed the most optimum time for combining hearing with directed reach will be delayed in developing the concept of causality. Blind children fail to perceive themselves as causal agents in activating toys or other objects and instead become dependent on others for stimulation. This early distruption in visually handicapped childrens' cause-effect relationships may play a significant role in the passive attitudes frequently observed in this population.

Deaf and Deaf-Blind Infants

Care must be taken to provide deaf infants with visible results for goal directed efforts and to minimize the number of toys that produce only audible feedback. Deaf-blind children face double jeopardy since their perceptions of auditory and visual feedback may be distorted, if perceived at all. These children may be unaware that anything can occur as a result of their behavior, and thus may not be motivated to repeat vocal or manipulative behaviors.

Physically Handicapped Infants

Physically handicapped childrens' involvement may be too severe to permit any manipulation of the environment. These children, then, lack the experience and opportunities needed to realize their potential as initiators of events. Cerebral palsied infants' attempts to initiate an action may result in abnormal postures or grimaces that may be misinterpreted as gestures of protest or resistance.

Severely/Profoundly Handicapped Infants

Profoundly handicapped infants' levels of arousal may be so depressed that they are oblivious to their surroundings and any possibility to effect change. Webb (1969) contended that:

> Some of these profoundly retarded children may be so inert that they give no apparent response to stimuli. Other brain injured youngsters seem to withdraw actively into autistic shells. Both situations seriously disrupt the normal development of recognizing pleasant and unpleasant

> stimuli, remembering past exposures to them and exercising discrimination in anticipating or avoiding future contacts with them. Without the ability to respond and respond selectively, profoundly retarded individuals cannot act with much preconceived or even immediate intentionality (p. 283).

All of these children have passed the teachable moment for understanding that movement can be used for a variety of purposes, from discovery and problem solving to play and communication.

CONSTRUCTION OF OBJECTS IN SPACE

The first opportunity the infant has to integrate visual and auditory processes in order to perform cognitively occurs in the domain of construction of objects in space (Stephens, 1968). It is in this domain that the child begins to understand relationships in space. A firm conceptual base in spatial constructs enables the toddler to begin to order events in the day, to search for objects and people associated with specific locales, and to attend to size, number, and time.

Emerging control over eye muscles and head control allows the infant to glance alternately at two stimuli and to visually localize sound sources. As the infant demonstrates an interest in the movement of objects, he or she follows the path of a toy as it topples from the highchair tray. Later the infant expands and confirms this concept of gravity with repeated tosses of bottles, green beans, and other tidbits. As the toddler moves out in space and explores, he or she learns that an object is the same regardless of its position in space: the bottle can be identified even if just the bottom is visible, a cup turned upside down is still something from which to drink. Later the toddler begins to organize these perceptions and experiments by combining two or more objects; for example releaseing pebbles into jars, stirring spoons in cups, and banging spoons on pans. From experiences like filling and dumping pails of sand, an awareness grows of the relationship among size, number, and space. The child learns there is only so much space to be filled before a container overflows. Attention to this spatial concept enhances the toddler's skill of organizing and orienting objects in order to balance one upon another. Moving in, around, over, and under spaces to retrieve balls, chase the family pet, and retreive an out of reach object not only teaches the child about his or her body, but also establishes the groundwork for basic positional and relational concepts.

Multiply Handicapped Infants

The sequence for developing the concept of space in multiply handicapped children will depend on the nature of the handicaps and their concomitant experiential gaps. A fragmented selection of learning experiences may also contribute to a scattered array of skill development often seen in multiply

handicapped children (Fieber, 1977). Training activities that are based on a naive understanding of the developmental sequence of spatial and quantitative reasoning can be responsible for significant learning gaps. For example, pegboards, block stacking, and container play behaviors are among the more popular fine motor activities conducted simultaneously in classrooms for multiply handicapped and severely/profoundly handicapped children. While students succeed in mastering the rote manipulative skills for such tasks, they may fail to learn the concepts upon which these activities are based. Early pegboard play offers the infant the opportunity to explore space, and container play teaches the infant that space is definable. Both learning experiences are prerequisites for understanding that cubes can be balanced only if their bases are aligned according to a limited amount of space. Is it any wonder, then, that the child who has learned these skills strictly by rote kinesthetic-proprioceptive feedback, experiences difficulty in progressing to concepts of size and number?

Deaf-blind and autistic individuals have particular problems in developing the concept of space. Their sensory impairments impede integration of physical and experiential events during critical learning periods.

Autistic Infants

Disturbances of perception have been considered an intrinsic feature of the austistic behavioral syndrome (Rutter & Schopler, 1978). Unable to modulate both internal and external sensory input, autistic children undergo alternating behavior states of hyper and hypo responsiveness to auditory and visual stimuli (Ornitz & Rivto, 1976). Table 3 lists behaviors resulting from faulty modulation of sensory input. (Rutter and Schopler, 1978).

According to Schopler (1956), autistic children favor touch, smell, and taste over vision and hearing. These children have been observed to exhibit fewer eye movements and to spend less time actually looking at things than do nonautistic children. They are also highly dependent on motor feedback for interpretation of perceptions (Ornitz & Rivto, 1976). The critical learning periods for visual discrimination, auditory localization, and visual-auditory association are interrupted in the autistic child as a result of the inability to direct and integrate the sensory systems that control attending, modifying, and interpreting environmental stimuli.

Deaf-Blind Infants

Deaf-blind infants' ability to form a concept of objects in relation to their surroundings will depend on the nature and severity of the handicap. Visual field deficits may keep the infant from following the path of an object as it falls or as it moves under or behind some barrier. A deaf-blind infant who has no clues as to where a lost toy has disappeared will not attempt to

TABLE 3

Percentages of 74 Autistic Children with
Disturbances of the Modulation of Sensory Input

Disturbance[a]	Number of children[b]	Percent with symptom
*Ignored or failed to respond to sounds	70	71
*Excessively watched the motions of hands or fingers	73	71
*Stared into space as if seeing something that was not there	73	64
Preoccupied with things that spin	73	57
Preoccupied with the feel of things	72	53
Let objects fall out of hands as if they did not exist	70	53
Preoccupied with scratching surfaces and listening to the sound	72	50
*Agitated at being taken to new places	73	48
*Agitated by loud noises	71	42

[a]Entries preceded by an asterisk represent variables used for assigning autism scores.
[b]The number of children varies and is less than 74 since some of the parents did not answer some of the questions on the clinical history.

Taken from Rutter, M., & Schopler, E. Autism: A reappraisal of concepts and treatment. New York: Plenum Press, 1978.

engage in search behavior. Lack of integration between vision and movement will also surface in the deaf-blind child's faulty depth perception and lack of skill in games such as ball rolling and catch. This child's ability to orient to a sound source, to locate an object by the sound made as it strikes a surface, and to associate familiar noises with their sources and locations will depend on the severity of the hearing loss. Table 4 provides a guideline to the types of auditory input that can be perceived at various hearing thresholds.

Knowledge of the developmental progression of sound localization is imperative when trying to decide whether a child's responses to sound stimuli indicate a hearing impairment or a mental deficiency. It is also necessary to understand this progression when teaching a visually impaired child to find an object by its sound cue. Table 5 outlines the developmental sequence of sound localization (Northern & Downs, 1978).

Infants with Motor Disabilities

The reflex system of the cerebral palsied infant may prevent the child from shifting gaze, turning toward sound sources, or tracking objects that fall or roll out of sight. The disability may also prevent the child from making the movements necessary to retrieve these objects. An infant with disabled or absent arms or legs is likely to have a difficult time forming healthy body images and understanding body relationships. This child must first learn how to relate his or her body to external stimuli before learning to integrate objects in play.

The ataxic and myelomeningocele child, both of whom display visual-perceptual disturbances, may encounter difficulty in forming three-dimensional images and in perceiving objects as being the same when viewed from different or unusual spatial perspective (Langley, 1979). Similarly, the realization may never occur to the blind child that the flat, smooth surface being patted is the back of the Busy Box. When the teachable moment comes for exploring objects in space, children with sensory impairments have not made enough observations to allow them to adapt to a different modality for orientation, mobility, and communication. Physically impaired and multihandicapped children, who have also failed to observe the full range of properties of objects, miss the time when their neurological system is prepared to integrate movement and sensory experiences. This foundation is needed in preparation for recognizing the functional orientation of objects and tools for problem solving and activation.

BEHAVIORS RELATING TO OBJECTS

The ability to coordinate and integrate seeing, hearing, sucking, and grasping enables developing infants to relate to objects, learn their names, and eventually, represent these objects and their actions in symbolic play. Infants suck their thumbs, bring their hands before their eyes, and shake

TABLE 4

Significance of Hearing Loss with Regard to
Auditory Function and Educational Potential

Hearing Loss in Better Ear	Auditory Function at a Distance of 5 Feet	Educational Potential and Requirements
less than 20 dB	Usually unnoticed. May misunderstand a whisper.	Clear speech and careful positioning in class may be all that is necessary.
20-40 dB	Misunderstands soft speech.	
40-60 dB	Misunderstands ordinary speech.	Some understanding of speech and language can be learned through the use of amplification.
60-80 dB	Misunderstands even loud clear speech.	The residual hearing should be helpful in perceiving vowel sounds, voice quality, accent, rhythm, and inflection patterns through the use of amplification, but correct language and speech cannot be learned without special techniques.
over 80 dB	Misunderstands very loud clear speech and shouts.	The child can "feel" sounds. He/she can perhaps profit by listening for rhythmic patterns including word and sentence stress, accent and inflection. This limited residual hearing is of greatest use in maintaining general environmental contact rather than in any direct relation to acquisition of language or speech.
complete	Very loud shout not heard.	

Taken from Holt, K.S. & Reynell, J. Assessment of cerebral palsy, Volume II. Berks, England and N.FE.R. Publishing, 1967.

TABLE 5

Developmental Progression of
Auditory Localization

Developmental Age	Localization Behavior
Newborn - 4 months	Arousal from sleep by sound signal.
3-4 months	Begins to make rudimentary head turn toward a sound.
4-7 months	Turns head directly toward side of a signal; cannot locate above or below him/her.
7-9 months	Directly locates a sound source to the side and indirectly below him/her.
9-13 months	Directly locates sound source to the side and directly below.
13-16 months	Localizes directly sound signals to the side and below; indirectly above.
16-21 months	Localizes sound signal on sides, below, and above.
21-24 months	Locates directly a sound signal at all angles.

Taken from Northern, J. L. & Downs, M. P. Hearing in children. Second edition. Baltimore, Md.: Williams & Wilkins Co., 1978.

rattles as part of their oral, visual, and auditorial explorations. In manipulating various toys the infant learns to discriminate which behavioral schemes to apply to specific toys. The discovery of the properties of objects helps in the infant's construction of what to do with them. Soft, squeaky toys are for squeezing; elongated, hard toys with things inside are for shaking. Once children understand the functions of objects and how to use them, they can acquire labels to represent them. Next, the infant becomes interested in showing objects to adults and in finding these things as they are named. As children learn through their play that some objects receive action and that others cause action, they begin to establish the groundwork for subject-predicate utterances. As the discover is made that various types of objects share the same attributes, the child begins to discriminate and associate new and similar characteristics for classification and generalization skills.

Blind Infants

Having already passed the most optimum time for developing behaviors that depend on vision and movement, the blind child is delayed even further at the stage of recognition and exploration. Frailberg, Smith, and Adelson (1969) emphasized that the blind child lives in a world of accidental encounters with things that materialize out of nowhere. At 8 months, the blind child who hears a sound he or she has learned to associate with a preferred toy will open and close his or her hand in anticipation of the toy. But, the blind child does not offer or show toys to adults, and thus, no foundation is laid for initiating interactions with others.

Concomitantly, opportunities to acquire and expand vocabulary are also limited, since the blind child is almost totally dependent on others to experience novel objects and to associate labels with tactile input. Limited in independent mobility until approximately 19 months, the blind child is not able to explore various rooms of the house, to touch objects of interest, and to have them labeled. Unless the blind child is taught systematic scanning and exploration strategies, the similarities between objects and the ability to make generalizations may not develop. The absence of visual opportunities to associate tactual properties with auditory input often leads to meaningless rote verbalization.

It should be noted that vision is the integrating variable between sound and touch in the normal child prior to 4 months of age (Fraiberg, 1977). Frailberg, Siegel, and Gibson (1966) cited evidence that the blind child may lag 6 to 8 months behind the sighted child in the integration of tactile and auditory schemas. Since the blind child cannot perceive large objects as integrated wholes, the child may become confused over the mearning of words. This child may feel four legs, fur, and something that moves, but is it a dog, a cat, or a rabbit? The child's images may be distorted and his or her perceptions may not match previous conceptual data. The most significant divergence from the sighted child in the development of object concept occurs around the first quarter of the second year (Frailberg, Smith, & Adelson, 1969).

Yarn and furry objects were the least preferred, while there were negligible difference in preferences for temperature and textures as represented by sand, wood, a nerf ball, and a brush. Danella hypothesized that light touch (yarn and fur) may be threatening to tactually defensive children and may elicit avoidance and withdrawal while vibratory effects relate to pressure and proprioception and may facilitate integration of incoming stimuli.

Neurologically impaired infants may manifest astereognosis, which is an inability to recognize objects that are placed in the hands. While the presence of the object may be perceived, the child cannot discriminate attributes of size, texture, temperature, or shape. Cerebral palsied children may have reflexes that prevent them from grasing and exploring objects, either visually or orally. Although limb deficient children can see and orally explore toys, the presence of prosthetic appliances will prevent tactual input as well as normal proprioceptive feedback.

Thus, when the teachable moment occurs for integrating sensory and motor input for concept formation, language development, and reasoning, faulty sensory feedback mechanisms interfers with the match between readiness and opportunity to acquire needed behaviors. The most obvious effects are seen in the severe generalization deficits and language delays in multihandicapped blind children, autistic children, and severely mentally retarded youngsters.

IMITATION

The development of imitation emerges in two forms: vocal and gestural. Early vocal patterns are used to convey levels of contentment and are expressed in cries and coos. As the infant's interest in vocalization increases, the listener can detect a differentiation of vowel and consonant sounds. The infant indicates recognition of sounds he or she has produced by vocalizing or increasing bodily activity, a form of pre or pseudoimitation activity. Later, as the child's maturational processes develop, more control over auditory and vocal mechanisms becomes possible and the child learns to imitate familiar sound patterns and words, modify familiar sounds, and finally generate unfamiliar sound patterns and movel words.

Gestural imitation follows a similar progession. First developed are simple, gross motor imitations of behaviors the child already has within his or her repertoire, followed by imitations of a variation on the motor pattern the child can perform. For example, if the child has been observed to wave his or her arms up and down, the caregiver may try to elicit imitation of waving a rattle up and down. Imitations of novel gestures the child can see himself or herself perform, such as banging two cups together or using the hand as a puppet (Dunset, 1978b), are the next to be acquired. As children become proficient in imitative abilities, they can imitate novel gestures which they cannot observe, such as tugging on their ears or clapping hands behind their back. A favorite such behavior of handicapped infants at this

Fraiberg, et al. reported that for the blind child, representations of real-life objects (baby dolls, toy cars) may have no meaning until 4 to 5 years of age.

Deaf-Blind and Autistic Infants

Commonalities exist between deaf-blind and autistic children in their approach to objects and initial object interactions. Both groups of children will use objects for self stimulation if not provided with opportunities for appropriate interaction and exploration in a functional context. The child's task at this stage is to generalize function across a variety of common but dissimilar attributes (e.g., big spoon, little spoon, white spoon, silver spoon, plastic spoon, metal spoon), settings, environments, and temporal relationships. Deaf-blind children who function at infantile levels often remain centered on their own bodies, engaging in light flicking, body rocking, and tapping or flicking objects or fingers before their eyes or against their mouths or tongues.

The autistic child's poor control of sensory input inhibits integration of early behavioral events and interrupts the normal sensory motor feedback process needed for more complex behaviors. Autistic children may exhibit no startle response to sudden, loud noises. They may be delayed in responding to visual, auditory, or tactile stimuli. Such children may walk into objects, ignore toys placed in their hands, and/or show no response to pain (Ornitz & Rivto, 1976). On other occasions, the same autistic children may actively seek out tactile stimuli by rubbing textures, scratching surfaces, or inducing vertibular and proprioceptive feedback by whirling, spinning, and rocking. In hyperresponsive states, autistic children may exhibit distress and avoidance reactions to unusually textured foods, to changes in illumination, to sounds such as sirens or vacuum cleaners, and to imposed vestibular or proprioceptive inputs (Ornitz & Rivto, 1976).

Intense attachments to specific objects, specific attributes (corners, tins, textures), and specific patterns of sameness often occur among autistic children. "Usually these attachments persist in spite of extreme distortions in the size or shape of the object, so that the function of the object is irrelevant to the attachment" (Rutter, 1978, p. 12). Such rigid, stereotyped behavioral reactions to objects limit the autistic child's concept formation, coding, and categorization processes.

Multiply Handicapped Infants

Danella (1973) investigated the tactile preference in multiply handicapped children. While her research focused primarily on mentally retarded children exhibiting additional hearing and vision impairments, Danella's findings have implications for other severely impaired learners. Among a set of nine objects selected to represent tactile qualities of temperature, texture, vibration, and density, vibration was significantly the most preferred quality.

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with objects and can repeat these behaviors at a later time in deferred imitation activities during play. Children may pat Mom's powder puff on their faces, or "smoke" the used popsicle stick. Through this form of representational play, children learn to manipulate symbols, an essential prerequisite to the development of language, imagination, logic, and abstract thinking. Best and Roberts (1976) found that the deaf infant parallels the hearing infant in the development of gestural imitation and there is evidence to suggest that the deaf infant is actually superior to the hearing infant in the rate of imitation (Schlesinger & Meadow, 1972; Wilber, 1979).

Multiply Handicapped Infants

The multiply handicapped-visually impaired child and the physically involved child are most effected by the disparity between cognitive readiness and sensorimotor opportunity. Chewing, scooping, facial expressions, and appropriate posture must often be specifically taught to multiply handicapped blind children becasue they lack the sensory perceptors to learn through modeling.

Blind Infants

The blind infant misses the critical period of watching Mom demonstrate chewing as she offers the baby bites of food. Even if the blind infant is ready to chew, his or her disdain for unusual textures and lumps may inhibit acceptance of food of consistencies that need chewing. For teachers and parents who have attempted to teach deaf-blind children to chew after 9 years of diets of pureed foods, little more has to be said regarding how difficult a task it is to teach a skill once the critical learning period has passed. Scooping food up in a spoon is also a difficult task for the youngster who cannot see the contents of the spoon or the twisting motion of the wrist needed to get the food onto the utensil.

With no opportunity to model a heel-toe gait or an upright position, blind toddlers may walk with toes out and head down, a gait that immediately betrays their sensory deficit. This gait may initially be functional in compensating for balance difficulties, but a more advanced gait frequently fails to develop because the child is unaware of any alternative.

Cerebral Palsied Infants

The effects of passing the teachable moment for acquiring imitation skills are reflected in the cerebral palsied child's delayed acquisition of communication skills and postural control. Natural childhood games such as pat-a-cake or peek-a-boo rarely emerge in the child retaining primitive reflex patterns. Attempts to bring hands to the midline are met with resistance or extraneous abnormal movements (Langley, 1979). The seriously physically limited child may never experience the appropriate kinesthetic or proprioceptive feedback that leads to spontaneous imitative patterns critical to acquiring independent self care skills.

MOTOR DEVELOPMENT

The relationship between movement and learning has been emphasized most significantly in the works of Piaget (1952). Movement serves as an integrating link in the progression of language, cognitive, perceptual, and social-emotional development (Rosenbloom, 1975). Holt (1975) referred to movement as the "fundamental characteristic of all living things" (p. 1). In relating the effects movements have on learning, Holt (1975) stated:

> In addition to the kinesthetic, stimuli, visual auditory, and tactile sensorimotor links develop to provide information which reveals the results of movements and in due course enables the brain to modify the position of movements, and to make use of movements for searching the environment. (p. 4)

Holt further summarized the goals of purposeful movement as those of increasing the infant's awareness level, facilitating manipulation of the environment, and enhancing communication.

There has been much discussion as to the degree of movement that is necessary for perception and subsequent development of problem solving and foresight. Held (in Rosenbloom, 1975) contended that some form of active movement is critical for the attainment of normal perceptual and visual motor abilities. Webb (1971) and, most recently, Zelazo (1979) offered an alternative hypothesis to the "move to learn" thesis in an endeavor to explain how severely physically involved children acquire cognitive competence. Webb suggests that the severely physically disabled child learns to anticipate, discriminate, and manipulate the environment by means of the visual system. Webb implied that the ability to direct visual attention is basic to learning and can be achieved either with or without gross motor ability. Zelazo (1979) hypothesized that perhaps the subtle motor responses such as eye movements or muscle contractions are sufficient for providing the feedback needed for learning and reasoning.

Postural Reflex Mechanism

The normal progression of motor skill acquisition is governed by certain basic neurological and developmental principles. A normal postural reflex mechanism is critical to the occurrence of any of the movement principles described below. Righting and equilibrium, both automatic reactions, comprise the postural reflex mechanism and are dependent on normal postural tone, normal patterns of coordination, and a normal balance of contraction and relaxation between muscle groups. The righting reactions, active from birth, enable the child to right his or her head against gravity, to develop selective trunk rotations, and to develop trunk extension against gravity (Stone, 1977). More specifically, the righting reactions serve to maintain the head in the normal position in space, keep the head and neck in alignment with the trunk, restore the normal position

of the head and trunk when any body surface contacts the ground, and make possible postural orientation and adjustment by vision (Bobath & Bobath, 1964). Equilibrium reactions appear around 6 months of age and modify and inhibit the righting reactions which should be well integrated between 3 and 5 years of age (Bobath & Bobath, 1964). The equilibrium reactions are responsible for maintaining and regaining balance when the center of gravity is displaced, and thus facilitate more selective, volitional movements. When righting and equilibrium reactions interact with each other and simultaneously co-exist with normal postural tone, they permit the child enough support for stability while still allowing him or her the flexibility for mobility. Voluntary performance of any motor skill is dependent on the modification and adaptation of the relationship between normal postural tone and the righting and equilibrium reactions (Bobath & Bobath, 1964).

Development of Sensorimotor Progression

Connor, Williamson, and Siepp (1978) have delineated several major principles that characterize the development of sensorimotor progression and have as their basis the understanding that infants learn from the sensation of movement and that sensory input initiates as well as guides motor output. The refinement of the following movement components is based on the presence of and integration with the normal postural reflex mechanism:

1. The infant achieves control over movement in cephalocaudal and in proximal-distal directions. Controlled movements are first established as the child gains head control and continue to progress until the child maintains his or her balance in independent walking. The first step toward fine motor control occurs proximally as early arm movements are initiated at the shoulder and are gradually refined distally to permit fine control over individual fingers for manipulation.

2. While motor development is a sequential process in that subsequent skills are dependent on previously acquired motor behaviors for their expression, it is also an overlapping process.

3. The progression from one developmental step to another is not smooth, as there is a merging of patterns rather than an isolated instance of competence (Wendt & Shaperman, 1970). While still in the process of mastering an earlier skill, the infant begins practicing components of the next sequential movement patterns. This practicing, in turn, modifies, elaborates, and refines the movements necessary for skilled performance of the earlier motor behavior (Salek, 1976). Increasing sensorimotor maturity and mobility emerges from stability and generalized total movement patterns.

4. Movements are gradually dissociated to allow the infant control over individual movements, allowing for a wide variety of selected movement possibilities. Inherent in all of these principles is the concept of neurological maturation and its relationship to opportunities to practice movement skills. Even though many stages of physical development evolve

directly as a consequence of neurological maturation (Rosenbloom, 1975), if opportunities are not available for practice of a specific motor pattern, further progression and refinement may be inhibited. A significant corollary to this concept that carries much instructional relevance is that practice may not be effective without maturational readiness (Wendt & Shaperman, 1970).

STAGE I OF THE SENSORIMOTOR PERIOD AND ITS RELATIONSHIP TO COGNITION

Integration, modification, and elaboration of reflex activity is the basis for the development of cognitive-adaptive behaviors. Along with reflexive attitudes, the neonate has within its behavioral repertoire sensory and motor capabilities. Significant to the motor domain is that rotation, extension, and flexion patterns are coordinated with sensory stimuli and reflexive responses to provide the infant with initial survival mechanisms (rotation of the head to seek food, reflexive shutting of the eyes to minimize intensity of light, extension of the neck to clear the nasal passages from the surface when prone).

Many of the infant's earliest activities are focused on achieving and maintaining stable postures against gravity. Early reflexive movements are directed toward antigravity postures that facilitate head control, sitting balance, and standing so that the child can employ eyes, ears, mouth, and hands to find out about the surroundings (Holt, 1975). Engaged in playful extension and flexion of legs or active waving of arms, the infant may accidentally encounter an overhead mobile. The sight or sound of this chance interaction motivates further exploration of this new experience.

Other circumstantial opportunities to integrate sensory and motor abilities for learning occur as the child, in a supine posture, tracks a small toy. The extension of the arm to reach for the toy may initiate an unexpected roll to the side and the emergence of a more complex skill. Similar learning may occur as mother and infant engage in a tugging game. With the extraction of the toy from his or her hand, the infant experiences the proprioceptive feedback critical for the emergence of voluntary release skills. Early hand to mouth behavior is modified when the infant brings toys to the mouth for exploration. This early hand-mouth activity is further elaborated for independent feeding. Thus, from the concolidation of early sensory and motor behaviors evolve the basic building blocks for subsequent learning. It is no surprise that a number of curricula for severely handicapped and for delayed infants specifically address activities for modifying sucking, grasping, visual and auditory attending, and movement experiences (Campbell, 1974; Dunst, 1978b; Spain, 1975; and Webb, 1969).

Cerebral Palsied Infants

Under normal circumstances, early reflex patterns are integrated by means of the righting and equilibrium reactions to allow for the attainment of more complex movement. The cerebral palsied infant is characterized by abnormal tone that precludes the development of the normal postural reflex mechanism and the integration of early reflexes for the progression of motoric milestones.

Abnormal tone and postures associated with cerebral palsy interfere with normal sensory and motor coordination. The child who is dominated by tonic neck reflexes may not be able to dissociate eye from head movements in order to shift gaze or to localize auditory stimuli. Neither may this child direct his or her gaze to initiate reaching and rolling. According to Norton (1972), it is the advanced pattern of rolling that prepares the child for visual perceptual skills that require pursuit, fusion, accommodation, and conjugative eye movements. The low tone child who cannot hold his or her head up will experience similar problems in establishing visual fixation and sound localization skills. The lack of proximal stability associated with low tone predisposes the child to other motoric milestone delays. Without stability around the scapula, the infant who, at 5 months, is cognitively ready to reach into space for a toy may lack the righting reactions in prone that permit him or her to do so. Lacking balance and stability, the child is prevented from shifting weight to free one arm for reaching. The effects of missing this cognitive and motor learning opportunity surface in the failure to develop extension patterns throughout the neck, spine, and hips and in arm and hand motion (Norton, 1972). Bobath (1967) saw 9 months of age to be the critical range for facilitating the normal tone and inhibiting abnormal postures in cerebral palsied infants.

Motor deficits and abberrations have also been noted in mentally retarded, blind, and autistic infants and toddlers. While specific motor dysfunctions are unique to each of these populations, some similarities have been reported. Common to mentally retarded and to blind infants are delayed motoric milestones, including immature postural reflex mechanism, and the persistence of primitive movement patterns (Stone, 1977). Ayers (in Harris, 1980) stated that many mentally retarded, blind, and autistic children initiate self stimulatory behaviors in an effort to provide vestibular input that may be lacking or deficient due to poorly integrated vestibular systems.

Mentally Retarded Infants

Schmitt and Erickson (1973) believed that delays in smiling and sitting behaviors are indictive of intellectual deficits; behaviors frequently lagging in all three groups. According to Neligan and Prudham (1969), a combined delay in walking and talking in sentences is a reliable predictor of mental deficiency at a young age. Molnar (1978) hypothesized that the motor deficits seen in mentally retarded youngsters may reflect a subtle impairment of the neuromotor system itself rather than a lack of interest in exploratory movement or an inability to learn. Observation of retarded non physically handicapped infants shows an absence of postural adjustment reactions past the optimum developmental acquisition period for chronological age. Molnar speculated that this discrepancy might be the result of an immature postural control mechanism which, in turn, might be responsible for the delayed motoric milestones. In a group of 53 retarded infants who exhibited motoric delays independent of neurological dysfunction, Molnar (1978) observed the emergence of postural reactions between 11 and 45 months of age, with a span of 22 months, in comparison with the emergence of the same reactions between 6 and 18 months, and a time span of 12 months in the normally developing child.

While primitive reflex patterns did not persist and the sequence of development followed the expected courses, postural adjustment reactions were delayed significantly (Molnar, 1978). Table 6 depicts the difference between attainment of postural reactions and motor milestones. For example, while reflexes such as the moro, asymmetrical tonic neck, and plantar grasp did not persist beyond the expected point of disapperance, the development of propping and tilting reactions was discrepant from the usual chronological point of occurrence.

Webb (1969) observed that the profoundly retarded child has great difficulty in achieving the upright position against gravity. Because these children lack this posture, Webb concluded that this population cannot establish stable physical or psychological relationships with the environment, cannot explore boundaries marking the physical space around them, and therefore cannot spontaneously form the concepts of body image and self concept.

In contrast with Molnar's results, Cowie (1970) reported the persistence of the moro, palmar and plantar grasp, and automatic stepping reflexes past the normal time of disappearance in a Down's syndrome population. Additionally, Cowie noted deficient traction and Landau responses, but attributed such abnormalities to generalized hypotonia (low muscle tone) frequently associated with Down's syndrome (Harris, 1980). Connolly and Russell (1976), Hanson and Schwarz (1978), and Zausmer (1978) also commented on the weakness evidenced by this group of children, particularly in the neck, back, hip, and elbow extensors. Zausmer attributed delays in head control, rising to a sit from sidelying, rolling, and knee standing to a weakness in neck, trunk, and arm musculature. Harris (1980) reported the mean age of walking in groups of institutionalized Down's children to vary from 27 to 38 months with the range extending to 7 years. While research (Hanson & Schwarz, 1978) has proved that early intervention plays a crucial part in facilitating motor acquisition and inhibiting delays in Down's syndrome infants, Connolly and Russell (1976) indicated that the optimum time for ensuring normal or even precocious attainment of motoric milestones is prior to six months of age. Table 7 displays a comparison of motor development achievements that have been reported for various handicaps (Connolly & Russell, 1976; Cruickshank, 1966; Fraiberg, 1977; Hanson & Schwarz, 1978; and Zausmer, 1978).

Blind Infants

The overwhelming impact that the loss of vision has upon the infant's readiness to move becomes apparent as one considers the areas of motor delay in the blind infant. While the progression of skill attainment follows the same route essentially, the divergence occurs between the achievement of postural readiness and actual self initiated mobility (Adelson & Fraiberg, 1974). Another difference involves the execution of rolling from the back to the stomach prior to elevation of the head and chest by use of arms. This same sequence has been observed in visually impaired multiply nandicapped infants (MacLean, 1980). The nature of the eliciting stimulus may be responsible for this aberration in the sequence. Rolling can be initiated by

TABLE 6

Mean Attainment Range of Postural Adjustment Skills and Related Motor Milestones in Retarded Preschoolers

Motor Behavior	Expected Age in Months	Mean Attainment Range
Sitting without support	6.8	16.60
Lateral propping	6	15.75
Tilting in supine	7	15.70
Tilting in sitting	7	15.70
Creeping on hands and knees	8-9	21
Anterior propping	7-8	19-57
Tilting in sitting	5-7	20-36
Tilting in quadruped	7-8	20-34
Standing without support	10-11	17-34
Posterior propping	9	16-33
Independent walking	12	28-46
Tilting in hands and knees	9-10	27-45
Tilting in standing	11-12	27-45

Adapted from Molnar, G.E. Analysis of motor disorder in retarded infants and young children. American Journal of Mental Deficiency, 1978, 83 (3), 213-222.

TABLE 7

Comparison of Motor Milestones in Children
with Various Handicapping Conditions

SKILL	NORMAL	CEREBRAL PALSIED	BLIND	DOWN'S[1] WITH PROGRAM	DOWN'S[2] WITH NO PROGRAM	DOWN'S[3] WITH PROGRAM
Head up, prone	1-3 mos.	12 mos.	4+ mos.			2.8 mos.
Elevates self arms prone	2 mos.		8.75 mos.			
Sits supported head steady	3 mos.			4.25 mos.		
Sits alone momentarily	5-8 mos.		6.75 mos.	10 mos.		8 mos.
Rolls independently	4 mos.			4.38 mos.	8 mos.	4.8 mos.
Rolls from back to stomach	6.4 mos		7.25 mos.			
Sits alone steadily	6-8 mos.	20 mos.	8 mos.		10 mos.	
Raises self to sitting	8.3 mos.		11 mos.			
Reaches	3-5 mos.	14 mos.	10 mos.			
Transfers	7-8 mos.		10+ mos.	10 mos.		
Crawls	7-8 mos.	26 mos.		12 mos.	12 mos.	8.6 mos.
Creeps	8 mos.		13 mos.	16 mos.	15 mos.	14 mos.
Pulls to stand	8-10 mos.		13 mos.	12 mos.		12 mos.
Steps supported (Cruises)	11 mos.		10.75 mos.	14 mos.		13.9 mos.
Stands independently	11 mos.	27 mos.	13 mos.	13 mos.	20 mos.	16.8 mos.
Walks independently 3 steps	11.7 mos.		15.25 mos.			
Walks unsupported	13-18 mos.	33 mos.	19.25 mos.	18 mos.	24 mos.	18.mos.

1. Adapted from Hanson, M. J. & Schwarz, R. H. Results of a longitudinal intervention program for Down's syndrome infants and their families. Education and Training of the Mentally Retarded, 1978, 13, 403-407.
2. Adapted from Zausmer, E. Gross motor developmental stimulation. In S.M. Pueschel (Ed.) Down Syndrome: Growing and learning. Kansas City, Kansas: Sheed Andrews and McMeel, Inc., 1978.
3. Connolly, B. & Russell, F. Interdisciplinary early intervention program. Physical Therapy, 1976, 56, 155-159.

proprioceptive stimuli and its effects on the labyrinths in combination with vestiges of a neck righting reaction. Normally sighted infants are most often enticed to hold up their heads by visual curiosity.

Mothers of Fraiberg's (1977) infants reported that their visually impaired children did not turn their heads from side to side when supported in an upright posture as do sighted infants. Neither did these infants like the prone position, perhaps because of the difficulty in moving against the pull of gravity. As a whole, visually impaired infants displayed delays in elevating themselves by their arms in prone, in raising themselves to sitting, in standing by furniture, in creeping (although rocking in a quadruped position occurred within sighted norms), and in independent walking. Skills accomplished within the normal developmental period included rolling from back to stomach, sitting alone, stepping when hands were held, bridging on hands and knees, and standing alone. No children in the Fraiberg study moved independently into their surroundings until they exhibited ear-hand coordination to sound cue alone at 10½ months. Shortly after this discovery of their potential for control over the environment, the Fraiberg infants crept and moved to search for toys beyond their reach. Adelson and Fraiberg (1974), in their analysis of this phenomenon, pointed to the significance of external stimuli at a distance in facilitating the weight shift critical for movement. However, Fraiberg (1975) noted a decrease in the gap between readiness for movement and independent locomotion when caregivers were successful in providing early experiences in auditory-tactile synthesis.

The blind infant's hands are major perceptual organs and yet the infant experiences more significant delays in his or her abilities to employ the hands in a functional manner than in any other developmental area. Observations confirm that at 5 months of age, the blind infant lying in the crib is still holding his or her hands in fists maintained at shoulder height (Fraiberg, 1977). Lairy and Harrison-Covello (1973) reported that the tendency of blind infants in the first year of life to maintain a posture of arms bent at shoulder level preempted spontaneous attempts to move their arms, engage in finger play, and bring their arms to midline. Adelson and Friberg's (1974) research confirmed the delay in mutual fingering and a paucity of midline activity. Also of note is an absence of transference of objects from hand to hand, and an inabiliy to maintain two objects simultaneously. If the blind infant's hand is touched with a cube, the infant will grasp the cube but will not take hold of a second one. If the first cube is dropped, there may be no search beyond contact with his or her body (Langley, 1980). Refinement of the blind infant's grasp follows the same schedule as the sighted child's; however, the blind infant may use a raking grasp to increase the chances of finding small objects.

Deaf Children

Deaf children with impairment of the semicircular canals can be expected to experience difficulty with balance, equilibrium, and reaction time. Errors in discrimination of visual temporal patterns have been observed in older deaf children (Rittenhouse, 1979). Schlesinger (1978) reported that deaf preschoolers often are precocious in their development of eye-hand coordination and fine motor control, especially children who rely on their hands for communication.

Autistic Children

Sorosky (1968) indicated that motor disturbances may appear intermittently in some autistic children, while others continuously exhibit deviant motor behaviors. Autistic infants have been noted to diverge from the normal sequence of motor acquisition. Ornitz and Rivto (1976) found that some autistic infants are precocious in their ability to sit without support but are quite delayed in pulling to a stand. Initially, autistic infants may exhibit very low tone, appearing limp and lethargic. A fluctuation between flacid and rigid postures may carry over into later years. Some autistic children under age 3 have been observed to arch their backs and hyperextend the neck for several seconds (Ornitz & Rivto, 1976). Period of trunk and body rocking are often interruped by periods of immobility. Hand flopping, clasping, posturing, and flicking are characteristic behaviors associated with autism.

While such sterotypic behaviors might be thought to detract from any learning situation, autistic children have been reported to learn best through tactile-kinesthetic input and to be quite adept at tasks requiring refined hand function (Ornitz & Rivto, 1976; Rutter & Shopler, 1978).

Two other groups of children for whom matching the appropriate motor stimulation with the critical learning period is essential for ensuring normal developmental sequences are spina bifida children and infants with congential limb deficiencies.

Children with Spina Bifida

Rosenbaum, Barnett, and Brand (1975) report the tendency of year old spina bifida children to exhibit definite delays in eye-hand coordination skills. Mild to moderate assymmetry of hand preference, evidence of posturing in the hands, mild decrease of tone and strength of upper limbs, and decreased range of motion at the shoulders were among the major deficits observed in spina bifida infants at 12 months (Rosenbaum, Barnett, & Brand, 1975). Shurtleff (1966) noted considerable delay in reading and writing skills of grade school spina bifida children who had not experienced an upright posture between 3 and 18 months. Their deficit in spatial organization was revealed by left right confusion errors and difficulty in distinguishing "d" from "b" and "e" from "3."

Rosenbloom (1975) found serious delays in the manipulative abilities of spina bifida children who ambulated by means of walkers or wheelchairs. According to Rosenbloom, these children missed critical manual exploration opportunities as a result of having to depend on their hands as a means of compensatory locomotion, i.e. maneuvering crutches and the wheels on their chairs.

Rosenbaum, et al., however, offered research suggesting that early training activities in visuomotor tasks reversed the trend toward poor hand-eye coordination in spina bifida children regardless of the severity of the motor impairment.

Amputees

The most significant factors contributing to the successful acceptance of artificial limbs or prosthetic devices are the timing of introduction of the limb and the degree of parental acceptance and support. Prosthetic limbs should be applied in concurrence with the developmental period of the missing limb and a developmental sequence of stimulation activities initiated. The child should be provided with upper limb prostheses between 6 and 9 months, when sitting balance is acquired. Lower limb prostheses are introduced when the child is ready to stand, but knee joints are not added until the child is ready for pivoting and climbing stairs (Challenor & Katz, 1974). Providing the child with the artificial limbs as early as possible is essential to the promotion of body symmetry, balance, function, and the incorporation of the limb into the developing body schema. If given the limb at the optimal readiness period, the infant will achieve purposeful control of the limb as part of his or her developmental progression without instruction (Wendt & Shaperman, 1970). Proficiency and skilled movement patterns are dependent on precise, consistent instruction and learning opportunities, but basic function is achieved within the normal developmental pattern. Table 8 displays the sequence of prehension with the cable hook as described by Wendt and Shaperman (1970). Wendt and Shaperman cautioned, however, that should the child not exhibit receptivity to the training sessions nor the appropriate physical or intellectual maturation, rejection and frustration are the byproducts of too early attempts to introduce the limbs or ancillary components of the limbs.

LANGUAGE DEVELOPMENT AND THE HANDICAPPED INFANT

A closely interwoven relationship among cognitive, affective, and linguistic behaviors emerges during the sensorimotor period, thus preparing the infant for communicative competence. A brief survey of the literature reveals the awesome ties between early attachment behavior and communication development and the devastating breakdown in the communication process that occurs when an infant is handicapped. Important to note, however, is that handicapped infants are more similar than not to normal infants in their language and communication development. With the possible exception of autism, handicapping conditions appear to affect primarily the rate of language acquisition, but the sequence of communicative progression remains essentially the same as for the normal child.

When language development is delayed or severely disturbed, the child's emotional and social growth may be seriously affected (Kastein & Gillman, 1976). A deficient and/or severely delayed language system is a common thread that spans the handicaps of autism, blindness, deafness, and other developmental delays. In some handicapped infants (Davis, 1978; Rivto, 1976), the language deficit is immediately obvious,

TABLE 8

Sequential Progression of Prehension Patterns with a Cable-Controlled Hook

Approximate Age	Prehension Behavior
9 Months	Child is fitted with harness
	Accidental opening of hook by shaking, pushing, pulling
	Maintains hook in open position
	Uses sound hand to close hook after opening
	Removes objects either manually or by shaking
	Tolerates holding objects in hook
	Tries to place object in hook
18 Months	Manually opens hook
	Acquires ability to control involuntary opening of hook
	Closes hook by cable
20 Months	Voluntary hook opening for grasping
	Opening of hook is not related to size of object
	Release of object by cable
	Interest in holding function of hook
24-30 Months	Purposeful applied use of hook for prehension
	Size of object not considered for hook opening
	Proficiency acquired in hook opening
	May not associate ability to operate hook with desire for grasping object from surface
36-48 Months	Skill acquired in positioning object in hook for accurate prehension from surface

Adapted from Wendt, J.D., & Shaperman, J. A study of development of prehension patterns: The infant with a cable-controlled hook. The American Journal of Occupational Therapy, 1970, 24 (6), 393-402.

while in others (Freedman, 1978; Schlesinger, 1978) it may not be detectable for quite some time. The three groups of children in whom speech and language deficits are predominant are those with (a) sensory deficits, (b) cognitive and central nervous system dysfunction, and (c) serious emotional deprivation or trauma (Kastein & Gillman, 1976; Menyuk, 1974). Fay (1973) stated that deficiencies in perceiving sensory input alone account for developmental language arrest which, in turn, is potentially instrumental in socialization delays. Kastein and Gillman (1976) implied that the blind child's level of language acquisition determines the extent of his or her successful adaptation to life. (See also Cicchetti and Stroufe, 1976; and Conner, Williamson, and Siepp, 1978 for studies of the relationship of motor impairment and affective development as it influences communicative interaction.)

The two most significant factors in the development of a meaningful communication system appear to be the establishment of reciprocal gaze patterns between infant and primary caregiver, and the infant's subsequent smiling behavior. By the end of the first month, the normal infant's ability to maintain eye contact with the mother is well established. This activity causes the infant to smile, which in turn motivates the mother to play more with her baby (Campbell & Wilson, 1976). Gunn, Berry, and Andrews (1979) postulated that looking behavior is an index of the infant's attempt to monitor the communication environment.

Blind Infants

Braiberg (1977) suggested that the blind infant's lack of eye contact with the mother inadvertently communicates a sense of disinterest in her. She is not reinforced by the directed visual gaze so motivating in the eyes of the sighted child. This may explain Lairy and Harrison-Covello's (1973) observation that blind infants tend to be played with or handled very little in the early months. Fraiberg (1977) observed that, while the blind infants in her study maintained contact with their mother's hands during feeding, they were delayed in extending their arms to communicate "pick me up" until 8 to 12 months of age.

Although blind infants smile to their caregiver's voice within expected developmental time frames, the only consistent, reliable way to elicit smiles in these infants is through tactile-kinesthetic contact. Freedman (1964) reported that it is not until 12 months of age that the blind infant's smile becomes spontaneous and takes on the elliptical shape of a mature expression. According to Lairy and Harrison-Covello (1973), the smile of the blind infant is less distinct and less frequent that the smile of the sighted child.

Deaf Infants

Schlesinger (1978) reported that parents of deaf infants may tend to interpret their infants' lack of reaction to auditory stimuli (parents' voices) as a form of oppositional behavior. Deafness is frequently a confusing handicap for parents in that the deaf infant reflexively vocalizes, coos, and smiles until 6 to 8 months of age. Without hearing any vocal feedback in response to these initial vocalizations of without early intervention techniques, the deaf infant's early sounds quickly extinguish (Horton, 1976).

Down's Syndrome Infants

Cicchetti and Stroufe (1976) and Gunn, Berry, and Andrews (1979) have researched the gaze, smiling, and laughing behaviors of Down's syndrome infants. Their findings revealed that while the developmental sequence of these behaviors was the same as that of normal infants, Down's infants lagged behind normal in the onset and frequency of smiles and laughter. They also tended to terminate their gaze at caregivers more than normal infants and they remained within the prelinguistic stage of communication longer than average. Additionally, Cicchetti and Stroufe discovered an inverse relationship between degree of hypotonia and the initiation of laughter in Down's infants. The more severly hypotonic Down's children exhibited laughted 3 months later than the Down's infants with less marked hypotonia. Freedman (1964) reported that institutionalized children were delayed 3 to 6 months in smiling at a familiar caregiver. Nelson (1979) cautioned that the retracted lips and tightness around the spastic child's oral musculature is often mistaken as a smile rather than being recognized as an overt sign of abnormally high tone.

The physical interactions shared between the infant and the caregiver also provide an avenue for fostering social linguistic reciprocity. Bobath (1967) noted that the first sensorimotor patterns experienced by the infant are in response to handlin. Campbell and Wilson (1976) implied that the attachment bond is strnegthened optimally when the infant has the opportunity to socially interact with the primary caregiver. Children with central nervous system fysfunction may neither be able to interpret the communicative signals of the caregiver nor respond meaningfully for sustained interaction. The severely impaired awareness and motor skill levels of the profoundly retarded infant compound and inhibit such children's ability to alter physical and social contexts and interactions (Webb, 1969). Inefficient coordination patterns interfere not only with the child's manipulations of objects but also with the ability to move in order to reject or to accept people. Webb elaborated:

> Because of the profoundly handicapped child's ineffectiveness in operating on his environment cooperation and competition cannot arise

> from social experiences and self identification cannot grow from satisfaction and frustration of basic needs through interactions with other humans. (p. 284)

Cerebral Palsied Infants

A mother's efforts to cuddle her severly disabled cerebral palsied infant may be met with body extension and retraction instead of the expected molding to her body. Such behaviors may cause a parent to feel rejected by the infant or it may seem that the child is experiencing physical discomfort from the way in which he or she is being held. A parent may feel ineffective as a caregiver, which further complicates and prohibits positive interactions with the child. Buch, Collins, and Gelber (1978) discussed the influence of abnormal body postures associated with cerebral palsy on the infant's ability to participate in language learning experiences. If the child is locked into specific body positions, he or she may be deprived of making the connection between his or her actions and their potential to effect change on the environment via other people. Because the infant's first sounds occur with movement, the severely involved child may lack the ability to dissociate head from trunk and trunk from hips to execute flexion, extension righting and rotation patterns that are critical for the production, differentiation, and variation of sounds. These movement patterns are also essential to the evolution of an efficient respiratory process and breath control for producing and sustaining sound (Davis, 1978).

Austistic Children

Mothers of autistic children report that such infants rarely smile and seem happiest when left to themselves (Rutter & Schopler, 1978). The most often cited characteristic of autistic children is their lack of eye contact. Rutter (1978) offered an alternative hypothesis, that the autistic child does not actually lack gaze behaviors, but employs them in a subtle, sophisticated manner (i.e., attending from the periphery of the immediate context or looking out of the corners of the eyes). Despite Freedman's (1964) statement that "smiling tends to remain intact despite substantial biological impairment" (p. 178) the autistic child's smile, when present, is frequently inappropriate to the situation.

Deficits in gestural communication and interactions have also been noted in the autistic child. Ornitz and Rivto (1976) stated that the autistic infant becomes limp or rigid when held and conveys no desire for companionship or stimulation. Common traits among autistic infants are infrequent crying, irritability, overreactivenss, and flaccid tone.

In describing the depravity of social responsiveness of the autistic child, Rutter reported that this population typically does not develop cuddling behavior nor exhibit a desire for a bedtime kiss. These infants fail to exhibit anticipatory postures or to extend their arms to be picked up. They do not greet their caregiver, nor do they follow the caregiver around the house as do other toddlers. Not only does this group of youngsters evidence little response to pain, but parents indicated that they are not approached by the child for help when hurt.

Recognizing the Teachable Moment

The simultaneous emergence of affective and communicative behaviors and integration with motor skill acquisition is dependent upon the caregiver's ability to recognize when and how to respond to the handicapped infant. Freedman (1978) postulated that language delays might be minimized or prevented if caregivers could learn to identify when the infant is optimally alert and ready to engage in interaction. Equally important is the ability to time the child's turn in the "turn taking" process to match the infant's gaze signal (or touch in the case of the blind infant, or body tension in the physically handicapped) indicating readiness for the reciprocal effort.

The cognitive antecedents to symbolic language development encompass object permanence, imitation, causality and behaviors relating to objects (Bricker & Bricker, 1973; Corrigan, 1978; Dunst, 1978a; Mclean & Snyder, 1977; Moore & Meltzoff, 1978; Morehead & Morehead, 1974). All of these branches of behavior emerge from the early gaze and physical-social interactions with the environment during the sensorimotor period. According to Horowitz and Dunn (1978), the sensorimotor period ends when the infant acquires language and uses a symbolic system. In support of this view, Moore and Meltzoff (1978) indicate that the child of 18 months of age has acquired that symbol system and that an internal representation of experiences has been well formulated. By 18 months of age, most infants have been babbling for quite some time and may already have a vocabulary of 10 to 20 words (Bzoch & League, 1971). If these words are to be used meaningfully, Moore and Meltzoff delineated three major prerequisites that must be within the child's repertoire and whicy emerge from the concepts of object permanence, imitation, causality, and behaviors relating to objects. These prerequisite behaviors are (a) symbolic representation of objects, events, and people; (b) the conception that objects continue to exist; and (c) the understanding that words can express spatial causal temporal relationships between people and objects.

For the development of labels and naming, Bricker and Bricker (1973) and McLean and Snyder (1977) stressed the importance of understanding the function of objects and how to relate to them. It is through actively watching, manipulating, and experimenting with objects that children learn to attend to both subtle and over properties of change (Nelson,

1973). Words related to some form of movement are among the first vocabulary items to be acquired. During the period from 12 to 18 months, the child simultaneously learns of the value of objects in attracting an adult's attention and of the potential of gestures and words to evoke cause-effect relationships. Corrigan (1978) pointed out a rough relationship between the onset of the child's knowledge of object permanence at 18 to 24 months and the preponderance of single word utterances. Also associated with this level of object permanence is the appearance of semantic categories representing recurrence and nonexistence (Corrigan, 1978). The most salient factor in regard to the language development of a handicapped infant is that the cognitive, sensory, or motor impairment impedes the natural evolution of interpersonal reciprocity. Therefore, if the infant lacks interest in or physically is limited in observing the environment, objects will have no meaning and no need exists for establishing a causal relationship with another person. The result is that the infant has no purpose for developing a reciprocal communication system.

SUMMARY

The subsequent developmental gaps that accrue from a mismatch between readiness and opportunity to learn are responsible for the lack of integration and delayed progress often inherent in the handicapped infant. An understanding of the similarities and differences that can be anticipated when a child is handicapped will provide a common ground for all intervention agents to begin to narrow the gaps and to synthesize the child's development. Our responsibility as educators is to facilitate spontaneous learning interactions between the infant and caregiver by being cognizant of (a) the effects a handicap has on the infant's social-affective, cognitive, motor, and linguistic potential; (b) the parallel and divergent developmental patterns associated with specific handicapped conditions; (c) ways of designing and teaching to caregivers alternative strategies for minimizing or preventing the effects of the handicap; and (d) ways of instructing caregivers to recognize when the infant is ideally ready to acquire information from an interaction in order to optimize the teachable moment.

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